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INSECTS ATTACKING THE PEACH IN THE SOUTH AND HOW TO CONTROL THEM

THE PLUM CURCULIO, San Jose scale, and peach borer are responsible for about nine-tenths of the damage caused by insects in peach orchards in the South. In addition, 15 other insects do more or less damage.

This bulletin contains brief descriptions of these insects and their work and presents methods for controlling them.

Experience has shown that much of the loss caused by insect attacks in peach orchards of the South can be prevented by the thorough and timely application of the control measures recommended in this bulletin.

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INSECTS ATTACKING THE PEACH IN THE SOUTH AND HOW TO CONTROL THEM

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THREE INSECTS of major importance attack the peach in the Southern States. These are the plum curculio,[1] San Jose scale,[2] and peach borer,[3] and at the present time 90 per cent or more of the total damage caused to the peach by insects in this region may be attributed to these species. Other insects of less importance that sometimes attack the peach in the South are the oriental peach moth,[4] shot-hole borer or fruit-tree bark beetle,[5] lesser peach borer,[6] grasshoppers,[7] peach-twig borer,[8] corn-ear worm,[9] terrapin scale,[10] West Indian peach scale,[11] squash bugs,[12] southern green plant bugs,[13] spotted cucumber beetle,[14] blister beetles,[15] tarnished plant bug,[16] green June beetle,[17] and rusty-brown plum aphid.[18] This bulletin gives a brief description and life history of each of these insects and enumerates measures for their control.

THE PLUM CURCULIO

The plum curculio, or peach worm, as it is frequently called by peach growers, is the most serious insect pest that directly attacks the peach fruit in the South, where it annually destroys or renders unmerchantable vast quantities of fruit. In 1920 this insect damaged the peach crop in Georgia alone to the extent of over $2,000,000. However, this does not mean that curculio-control measures are in-

[1] *Conotrachelus nenuphar* Hbst.
[2] *Aspidiotus perniciosus* Comst.
[3] *Aegeria exitiosa* Say.
[4] *Laspeyresia molesta* Busck.
[5] *Scolytus rugulosus* Ratz.
[6] *Aegeria pictipes* G. & R.
[7] Several species of the family Acrididae.
[8] *Anarsia lineatella* Zell.
[9] *Heliothis obsoleta* Fab.
[10] *Lecanium nigrofasciatum* Perg.
[11] *Aulacaspis pentagona* Targ.
[12] Several species of the family Coreidae.
[13] *Nezara viridula* L. and other species.
[14] *Diabrotica duodecimpunctata* Fab.
[15] *Pomphopoea aenea* Say.
[16] *Lygus pratensis* L.
[17] *Cotinis nitida* L.
[18] *Aphis setariae* Thos.

effective, as experimental data and practical experience both have shown that the insect can be controlled effectively by thorough and timely spraying, reenforced, in cases of unusually heavy infestation, by supplementary control measures. By the use of the proper sprays at the right time, fruit showing less than 2 per cent curculio infestation has been produced in orchards where the insect had been unusually abundant. In the absence of control measures, over one-half of the fruit is sometimes wormy, or is gnarled from curculio feeding punctures.

The plum curculio is a native American insect, and is widely distributed east of the Rocky Mountains, being especially abundant in the Southern States. It is not known to occur west of the Rocky Mountains. The females injure the fruit by puncturing it for egg deposition; the result is a wormy peach (fig. 1), while both sexes cause gnarly fruits by making punctures in feeding (fig. 2).

FIG. 1.—Peach showing larva or "worm" of plum curculio. Two-thirds natural size. (Quaintance)

The curculio not only damages the peach directly, but the rupture of the skin for feeding or egg laying furnishes a place for the brown-rot fungus to enter. Many of the brown-rot infections in southern peach orchards start in this manner. Therefore, a heavy curculio infestation opens the way for brown-rot infections.

A majority of the small peaches that are punctured by the curculio early in the season fall to the ground within a few weeks after the calyxes, or "shucks," have been pushed off. However, the worms remain in them and grow until, having reached maturity, they make their way out of the fruit and enter the soil to transform to adult beetles. Two generations of the plum curculio frequently occur in the South, and during seasons when the insect is two-brooded, the eggs for the second generation are laid by the beetles that are reared from eggs deposited in the small peaches. Therefore, during those years, the worms in the late varieties of peaches in southern orchards are mostly second-generation larvae.

LIFE HISTORY AND HABITS

The plum curculio passes through four stages in its course of development, namely, the egg, the larva or worm, the pupa or stage of transformation, and the adult or beetle. The adult is a hard snout

beetle, is about three-sixteenths of an inch in length, and of brown color mottled with gray. (Fig. 3.) The egg of the curculio is rather elliptical in shape and has a smooth shiny surface and whitish color. The full-grown larva, or grub, is about three-eighths of an inch in length, and is of a yellowish-white color with a brown head. (Fig. 1.) The pupa measures from one-eighth to one-fourth of an inch in length and is white.

The insect passes the winter as an adult under leaves, grass, bark, sticks, and rubbish in woodlands adjacent to and near peach orchards, and under grass and trash in the orchard or along terrace

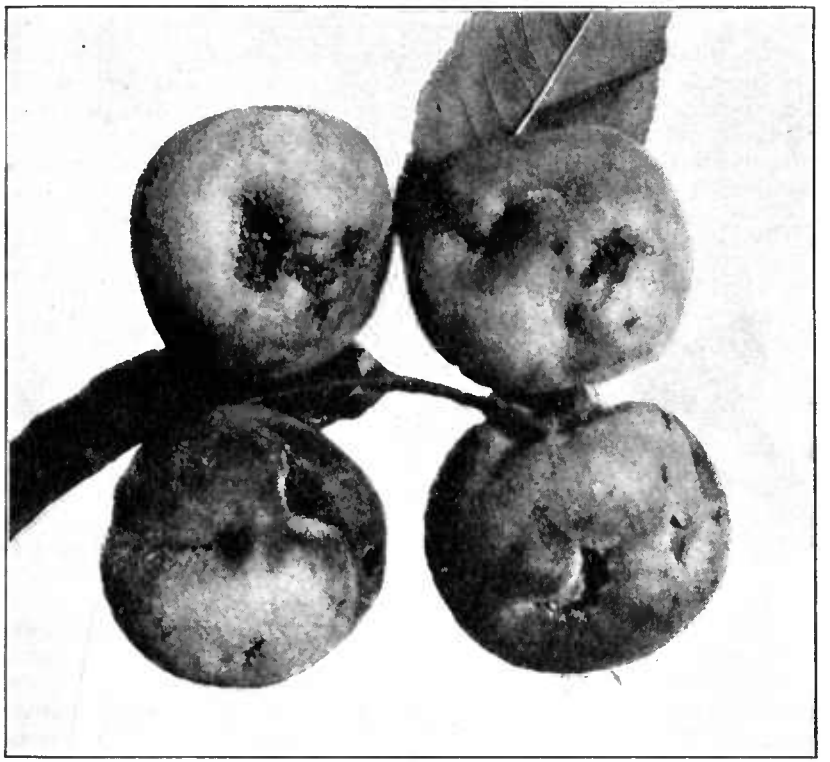

FIG. 2.—Peaches gnarled as a result of curculio feeding and egg-laying punctures. (Quaintance)

rows and fences. Bermuda grass and Johnson grass perhaps furnish the best hibernating quarters in and near the peach orchards. The beetles start to leave hibernation in the South just before full bloom of the peach, and they are usually in the orchards in numbers by the time the trees are in full bloom. Immediately upon arriving in the orchard from hibernation the beetles start to feed on the blooms, particularly the calyxes, and to some extent on the unfolding leaves. Mating takes place during this period of heavy feeding, and by the time the calyx splits from the small peaches the females are ready for egg laying. The egg is deposited in a small cavity, which the female makes with her snout, just under the skin of the peach, after

the fuzz has been neatly brushed back. The incubation period of the egg ranges from 2 to 12 days, depending upon weather conditions.

Upon hatching, the small larvae or worms begin feeding on the flesh of the peach, in most cases boring into it until the pit is reached. The larvae reach maturity in the fruit in about two weeks, when they eat their way out and enter the soil to pupate. Transformation from larva to adult takes place in a soil cell, constructed within 2 or 3 inches of the surface. The time spent in the soil by the curculio as a pupa is about 10 days, and the entire time spent in the soil as larva (in preparing the cell), pupa, and adult (before emerging) is 30 to 35 days. Therefore from 50 to 55 days is required in the South for the curculio to complete its life cycle from egg to adult. Weather conditions greatly influence the length of each stage in the development.

Two generations of the plum curculio are usually reared in southern peach orchards when an early spring causes the overwintering adults to leave hibernation before the normal time, and when favorable climatic conditions prevail during the time that the insect spends in the soil for pupation. When the beetle is kept in hibernation by cold weather until the latter part of March or when a cold April or May retards pupation, only one generation is produced annually. During years when there are two generations in the South all varieties of peaches ripening before the Hiley will not be subjected to the second brood of larvae. The Hiley will usually escape injury, although the last few pickings may show the presence of tiny second-brood curculio larvae, but the Georgia Belle and Elberta will be attacked by second-brood "worms." Second-brood adults emerge from the soil during August. Thus in September, during years when the insect has two generations, there are both first-brood and second-brood adults in the orchards. The beetles migrate toward woodlands or other suitable places for hibernation with the approach of cool weather, and usually by the middle of October they are all in hibernation for the winter.

FIG. 3.—The plum curculio; adult beetle. Nine times natural size

CONTROL MEASURES

Spraying or dusting with lead arsenate will afford adequate protection against the curculio in southern peach orchards when a normal infestation occurs. When abnormal curculio conditions occur, as they do sometimes during seasons when the insect is two-brooded, other control measures must supplement the arsenical treatments, if a large cull pile of wormy peaches at harvest time is to be prevented.

The most effective supplementary control measure is the collection and destruction of peach "drops." (Fig. 4, A.) Since a majority of the small peaches that are punctured early in the season by the curculio fall to the ground, the collection and destruction of drops

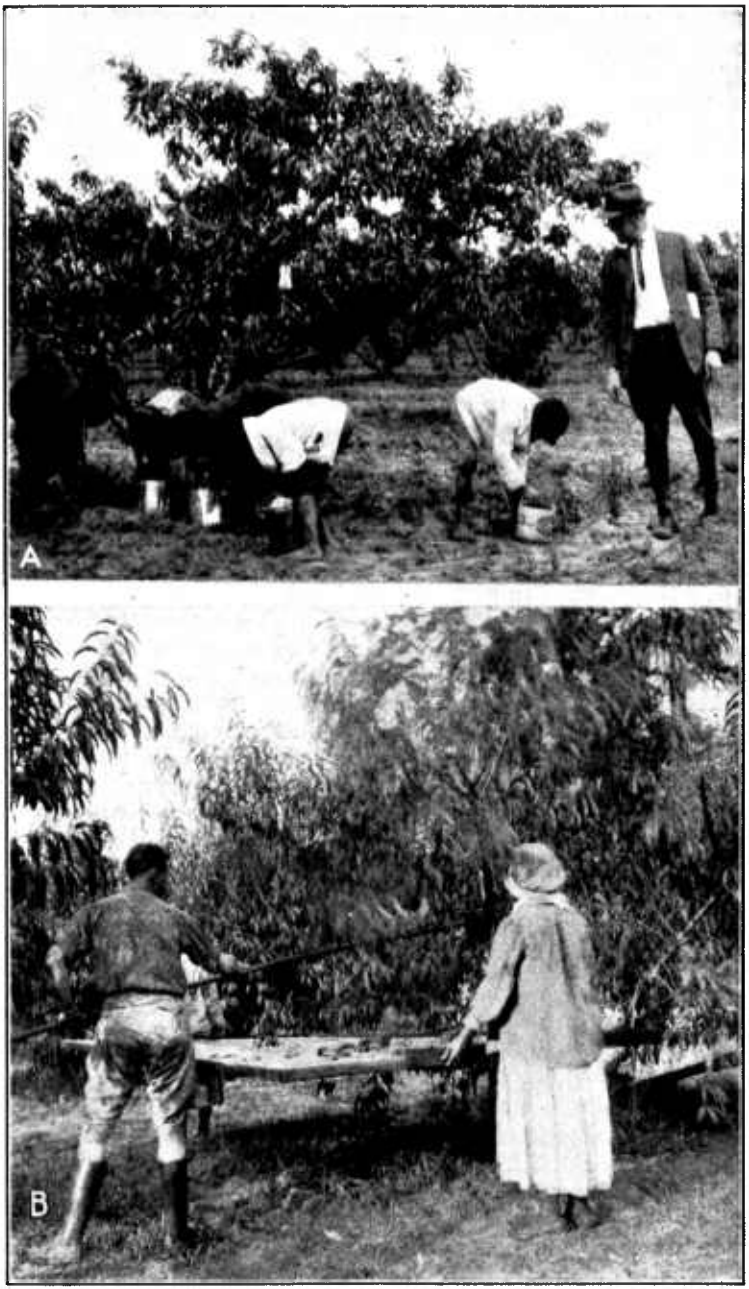

FIG. 4.—A, Picking up peach "drops" in a Georgia peach orchard; B, jarring peach trees to capture adult curculios

prevents the development of many adult beetles (which otherwise would cause wormy peaches at harvest in years when the insect has two generations) and leaves fewer beetles in the orchard after harvest to hibernate and attack the crop the succeeding year. Three collections of drops will get about 90 per cent of the worms that fall to the ground in peaches during the season. The first collection should be made about one month after full bloom, or when there are enough drops down to warrant a collection, and the other two should be made at intervals of five or six days. All drops should be made harmless as soon as they are collected, either by burying in a trench 18 to 24 inches below the surface of the soil and covering with a layer of quicklime before filling in with soil, or by submerging them in boiling water.

Since many curculios winter as adult beetles in woodland and similar cover adjacent to and near peach orchards, the burning over of such places during the winter months undoubtedly destroys many beetles, and is a valuable supplementary control measure wherever the curculio has been particularly troublesome. As most of the hibernation takes place within 200 or 300 yards of the orchard, the burning over of wooded areas should not be extended beyond that distance. In burning woods bordering orchards, great care should be taken not to let the fire escape. Under some conditions burning, as advised, may be objectionable from the standpoint of injury to young forest growth. It is a matter of judgment on the part of the orchardist whether burning is advisable or not. Vegetation on terrace rows and along ditch banks and fences in and near the orchard should also be burned or grubbed out. Sometimes as high as 65 per cent of the beetles that enter Bermuda grass in the fall for hibernation will survive the winter. Prunings, rubbish, and brush piles should not be allowed to remain in the orchard during the winter.

Another supplementary control measure which fits in well with the usual orchard-management program consists of disking under the spread of the trees from about May 10 until the last of June (in Georgia) to destroy curculio pupae in the soil. If the soil cells, which are constructed by the larvae, are broken after the insects have changed to the helpless delicate pupae, the heat and pressure of the soil will cause the death of many of them. In addition to the direct killing of the pupae, the disking perhaps indirectly causes the death of many by exposing them to the elements and to predacious enemies. The disking for destruction of pupae should be frequent, each week if practicable, and to a depth of several inches.

It is possible to collect many beetles in the spring by placing two 6-foot by 12-foot jarring frames under the peach trees and jarring the trees with a padded pole. (Fig. 4, B.) Some growers have found this control measure to be very profitable, especially near woodlands or other hibernating places, where the beetles concentrate just after leaving hibernation in the spring. When the beetles are disturbed, as the trees are jarred, they fold their legs and fall immediately to the sheets, from which they can be collected and placed in a can of coal oil. The beetles are less active early in the morning than at any other time, and jarring can best be done before the sun is very high.

SPRAYING AND DUSTING RECOMMENDATIONS

Spraying or dusting peaches at the several specified times during the period of development of the fruit on the trees is indispensable if the curculio is to be successfully controlled. Since the adult curculios are out on the trees in numbers by the time they are in full bloom, feeding on the calyxes or "shucks," it has been found that an application of lead arsenate when 75 per cent of the petals are down will kill many beetles before egg laying starts. This early application reduces the curculio infestation in the peach "drops," which correspondingly reduces the curculio population at harvest time. As a weapon against a second brood of "worms," and to prevent surviving adults of the preceding winter from ovipositing heavily during the ripening period of the fruit, lead arsenate should always be used on each variety four weeks before the fruit of the variety in question is due to ripen.

As a result of experiments and studies conducted in the South for a number of years, the following spraying and dusting schedules are recommended for use in southern peach orchards for the control of the curculio.

SPRAYING SCHEDULE

First application.—When 75 per cent of the petals (pink part of flower) have fallen, use 1 pound of powdered lead arsenate, with milk of lime from 3 pounds of unslaked lime, to each 50 gallons of water.

Second application.—When the calyxes or "shucks" are shedding, or when the small peaches are exposed (this is usually about 10 days after the falling of the petals), use the same spray as recommended for the first application.

Third application.—Two weeks after the second application, or about four weeks after the petals have been shed, use self-boiled lime-sulphur, 8–8–50, alone, for control of brown rot and scab.[19] (No lead arsenate is used in this application.)

Fourth application.—Four weeks before each variety is due to ripen, spray with 1 pound of powdered lead arsenate to each 50 gallons of 8–8–50 self-boiled lime-sulphur.

If a grower fails to make the first application he should then use lead arsenate in the third application with the self-boiled lime-sulphur, but this should never be done unless for an unavoidable reason the first spray could not be applied. Lead arsenate should not be used in all of the four applications of the above schedule, on account of the risk of injury to foliage and fruit.

Early peaches should be sprayed three times. Use the materials recommended for the first, second, and fourth applications above, applying them at the time specified for these sprays. For added protection against brown rot in early varieties, self-boiled lime-sulphur should be used in the second application.

DUSTING SCHEDULE

First application.—When 75 per cent of the petals (pink part of flower) have fallen, use either lead arsenate 5 per cent and hydrated

[19] More specific information on the control of brown rot and scab, and on self-boiled lime-sulphur and its substitutes, can be obtained from Farmers' Bulletin 1527, "Peach Brown Rot and Scab," by John W. Roberts.

lime 95 per cent; or sulphur 80 per cent, lead arsenate 5 per cent, and hydrated lime 15 per cent.

Second application.—When the calyxes or "shucks" are shedding, or when the small peaches are exposed (this is usually about 10 days after the falling of the petals), use either one of the dust formulas recommended for the first application.

Third application.—Two weeks after the second application, or about four weeks after the petals have been shed, use sulphur 80 per cent, lead arsenate 5 per cent, and hydrated lime 15 per cent.

Fourth application.—Four weeks before each variety is due to ripen, dust it with sulphur 80 per cent, lead arsenate 5 per cent, and hydrated lime 15 per cent.

Early varieties need only three dust applications, using the formula containing lead arsenate and lime, or sulphur, lead arsenate, and lime, at the time indicated above, for the first dusting, and the formula containing sulphur, lead arsenate, and lime at the times indicated above for the second and fourth dustings.

When the curculio infestation during the peach season has been very heavy, postharvest applications of lead arsenate may be found profitable as a protection to the next peach crop, by reducing the number of beetles in the fall before they go into hibernation and while they are forced to feed on the foliage. Two applications of a dust containing 10 per cent lead arsenate and 90 per cent hydrated lime should be used, making the first treatment four weeks after the harvest of the latest variety of peaches, followed by the second application two weeks later. The first application should not be made sooner than four weeks after harvest, as for several weeks following harvest the curculio feeds considerably on the fruit left in the orchard. Postharvest applications of lead arsenate as a liquid spray should not be used after the regular liquid sprays have been given the fruit, on account of foliage injury.

THE PEACH BORER

The peach borer is one of the most serious insect pests that attack the peach tree. Each year it directly or indirectly causes the death of many peach trees in both home and commercial orchards throughout the Southern States. Like the curculio, the peach borer is a native American insect. Although it is chiefly a pest of the peach, it is sometimes a serious pest of cultivated plum trees and has been found breeding in wild plum along the roadside. Peach trees of all ages are attacked, and frequently trees are found to be infested the first year after they are set in the orchard. The injury is done by the larvae as they feed on the cambium or growing tissues of the tree. (Fig. 5.) Young trees are sometimes completely girdled by the insect, and while older trees are less likely to be completely girdled, they are often so severely injured that their vitality is lowered and their resistance to other insects or diseases reduced to such an extent that some secondary pest will complete the destruction of the tree. Peach-borer injury usually takes place on the trunk just below the surface of the soil, although injury may be found on the trunk just above the soil level. The larger roots are also sometimes subject to borer attacks. The presence of borers in a peach tree is usually indicated by gum, particles of wood, and frass. (Fig. 6.)

For many years entomologists endeavored to find an effective control measure for this insect. Their efforts were almost entirely in vain until a few years ago when the value of paradichlorobenzene for its control was discovered. When properly used at the right time, this chemical brings about a high rate of control, and as a result the peach-borer problem has been largely solved.

FIG. 5.—Peach tree severely injured by the peach borer. About one-half natural size. (Quaintance)

LIFE HISTORY AND HABITS

During its period of development the peach borer passes through four stages, namely, the egg, larva or borer, pupa, and adult or moth. The adult of the peach borer is a clearwing moth. The female (fig. 7, B) is noticeably different in color markings from the male (fig. 7, A), and is usually larger and more robust. The color of the female is dark steel blue, and it has one orange band around the abdomen. The fore wings of the female are opaque, while the hind wings are clear except for the margins. In the male both sets of wings are clear. The male is a lighter steel blue than the female, and has several narrow yellow bands around the abdomen. The egg of the peach borer is reddish brown in color, has one end broader than the other, and measures about one-fiftieth of an inch in length. The larva or borer (fig. 5), when full grown, measures about 1 inch in length, is of a yellowish-white or cream color, and has a dark-brown head. The color of the food eaten by the larva sometimes causes its color to vary. The pupa has a dark-brown color and measures about three-fourths of an inch in length. There are stiff spines over the back and sides of the pupa that assist the moth in escaping from the cocoon when it is ready to emerge.

The winter is passed in the larva, or borer, stage, the younger larvae living in a more or less dormant condition throughout the winter in a covering constructed on the bark of the tree outside of the burrow, whereas the larger ones pass the winter within their burrows in the bark of the tree, and feed to some extent during warm periods. In the Gulf States the first larvae reach maturity during the latter part of June, when they construct silken capsulelike cocoons into which have been woven particles of wood and excrement, which give the cocoons a brown color. In this cocoon, which is usually found near the surface of the soil, either at the head of the borer gallery or in the soil close to the trunk, the full-grown larva changes to a pupa.

FIG. 6.—Gum and frass at base of peach tree, indicating presence of the peach borer. (Quaintance)

The pupa becomes fully matured in from three to four weeks, when it works its way out of the cocoon, and the adult moth emerges. A few moths may emerge in the southern part of the Gulf States during the latter part of July, but the heaviest moth emergence in the South occurs during September. Oviposition, which usually lasts only a few days, begins shortly after the moths emerge. A female moth usually deposits from 400 to 500 eggs, which are mostly laid on the tree trunk, although some are deposited on the limbs and leaves, and even on weeds and soil near the tree. The length of the incubation period depends on weather conditions. During July, August, and the early part of September, in the South, the eggs hatch in eight or nine days.

Upon hatching the little larvae crawl or fall to the lower part of the tree trunk and usually enter it at the surface of the soil. They

may bore directly into the bark, although they sometimes enter a crack in the trunk, and feed rapidly on the bark layers and cambium of the tree after gaining entrance. With favorable feeding conditions they attain considerable size within a few weeks. A few of

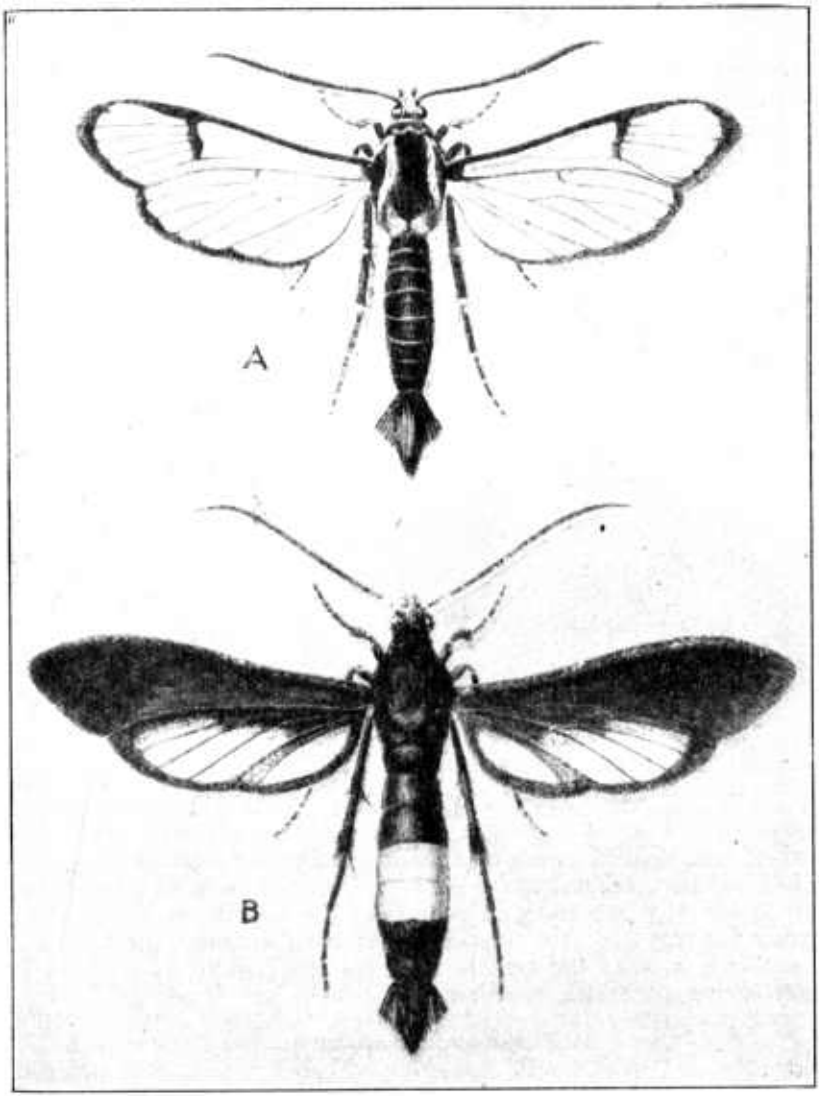

FIG. 7.—Peach-borer adults: A, Male; B, female. Two and one-half times natural size. (Qualntance)

the late-hatched larvae grow very little before spring, and it is not uncommon to find larvae only one-fourth inch in length during March and April. Practically all of the eggs have hatched, and the little borers are within the trees by October 10 in the latitude of Fort Valley, Ga. From 20 to 30 borers have been found in a single tree;

however, the number usually found in peach trees in Georgia will average about 3. There is but one generation annually.

CONTROL

For many years peach growers wormed their trees to protect them from the peach borer. Even at its best, worming is not a satisfactory control measure, as borers are often missed, and the injury to the tree from worming instruments is often more severe than that from the insect. If carefully done, worming will keep the insect in check reasonably well, but it can not be classed as a very effective control measure.

FIG. 8.—Trees that are to be wormed should be mounded during the summer. (Quaintance)

The worming process consists of mounding the trees in early July in the South (fig. 8), so as to force the small larvae to enter the tree higher up than normally. This makes it easier to locate the borers during the worming process in the fall. The worming is usually done in November or December. The mounds are torn down, and the soil is removed from the base of the tree to a depth of 6 or 8 inches. The borers are then removed with a sharp hawk-bill knife. In worming peach trees the incisions should always be made vertically if possible, and care should be exercised not to injure or cut any more of the sound wood than is actually necessary in removing the borers or crushing them in their burrows. After the trees have been wormed, the soil should be replaced around the tree to decrease the possibility of injury to the trees from freezing weather.

PARADICHLOROBENZENE

The work with toxic gases against the peach borer by E. B. Blakeslee, of the Bureau of Entomology, which was begun in 1915 and continued until 1918, demonstrated the value of paradichlorobenzene as an effective control for this destructive peach pest. The continuation of the paradichlorobenzene studies by the Bureau of Entomology at Fort Valley, Ga., from 1921 to 1927, inclusive,[20] and

[20] Technical Bulletin 58, U. S. Department of Agriculture. "Paradichlorobenzene Experiments in the South for Peach-Borer Control," by Oliver I. Snapp and Charles H. Alden, 1928.

the results of work carried on by several of the agricultural experiment stations, notably those of New Jersey and Illinois, have enlarged the knowledge of the use of this valuable insecticide.

Paradichlorobenzene is a white crystalline material, insoluble in water, and it has a characteristic odor somewhat resembling that of ether, which is irritating to the mucous membrane of the nose. Crystals of about the fineness of granulated sugar have been found most satisfactory for peach-borer control. They vaporize slowly at ordinary temperature, and the vapor is much heavier than air. Temperature and moisture greatly influence the rate of evaporation of paradichlorobenzene crystals. The higher the temperature and the drier the soil the more rapid is the generation of the gas from the crystals. Continually wet soil may prevent the normal diffusion of the gas through it, and thereby cause a gas concentration near the ring of crystals. The gas is deadly to insects when confined in the vapor, but is not poisonous to man or domestic animals. When the material is applied properly and at the right time, as specified in the directions given below, a 90 to 100 per cent control may be expected. In addition to the high rate of control, paradichlorobenzene has another advantage over worming in that its use avoids serious injury to the trees, which often results from the use of worming tools in the hands of careless laborers.

AGE OF TREES

Paradichlorobenzene can be used with safety on healthy peach trees 4 years of age and older. It should not be used on trees from 1 to 3 years old, as experiments have shown that these younger trees may be severely injured by paradichlorobenzene under certain weather conditions. It will be necessary for southern peach growers to continue to use the old method of worming 1, 2, and 3 year old trees for borer control.

SIZE OF DOSE

For peach trees 4 or 5 years old, use three-fourths of an ounce of the chemical per tree. For trees 6 years of age and older, of average size, use the full 1-ounce dose per tree. Doses of 1¼ ounces should be used on very old trees, if the trunks are unusually large.

WHEN TO APPLY

Experimentation has shown that best results with paradichlorobenzene for peach-borer control are obtained in the fall at the end of the oviposition period of the insect. At that time the borers are small and more easily killed by the gas. The material should not be applied earlier on account of the possibility of a late infestation becoming established, and on the other hand the application should not be delayed because very little volatilization of the chemical takes place after the soil temperature drops below 60° F. In the latitude of central Georgia the chemical should be applied between October 10 and 15, in north Georgia between October 1 and 5, and in south Georgia between October 15 and 20. In the mountainous section of northeast Georgia the chemical should be applied between September 25 and October 1. Paradichlorobenzene should be applied on the

same dates in similar latitudes of other Southern States. The desired results can not be expected unless the material is applied on or very close to the dates recommended, and growers are cautioned to give careful attention to this point.

PREPARING THE SOIL

No preparation of the soil is necessary except the removal of grass, weeds, and trash for about a foot from the tree trunk, and then

FIG. 9.—Applying paradichlorobenzene with a handy cone-shaped container that holds exactly 1 ounce

smoothing the soil surface with the back of a shovel. (Fig. 10, A.) Do not mound the trees before applying the paradichlorobenzene unless borers are working in the tree trunk above the soil level. As the gas from the chemical is much heavier than air, any borers working in the tree above the point where the ring of crystals is placed will not be affected by the gas. (Fig. 11, A.) Consequently it is necessary to place the crystals at least at the level of the topmost borer gallery. Should there be indications of borers working in the

tree trunk just above the soil level, sufficient soil should be placed around the tree to bring the level of the soil up above the gummy exudation before applying the chemical.

HOW TO APPLY

The material should be applied in a continuous band about 1 or 1½ inches wide around the tree, and about 1 or 1½ inches from the trunk. (Figs. 9 and 10, B.) Avoid placing the crystals against the tree (fig. 11, B), or too far from it (fig. 11, C). Several shovelfuls of soil free from stones, sticks, and trash should then be placed on the ring of crystals in the form of a mound and packed with the back of a shovel. (Fig. 10, C.) This mound serves as a container for the gas and prevents surface washing of the crystals. The packing of the soil after it is placed on the chemical is important in order to prevent surface loss of the gas. Avoid pushing the crystals against the tree trunk with the first shovelful of soil when covering them.

LATER ATTENTION TO MOUNDS

In using paradichlorobenzene around 4 and 5 year old peach trees, growers are advised to tear down the mounds 28 days after applying the chemical to trees of those ages, in order to remove all unspent crystals and to allow the confined gas to escape. As an added precaution against injury to the older trees, it is also advisable to tear down the mounds six weeks after making the application to trees 6 years of age and older. If the soil is removed from below the original soil level in tearing down the mounds, it should be replaced before cold weather sets in.

GRADE OF PARADICHLOROBENZENE

Orchardists are strongly advised to use only unadulterated paradichlorobenzene, and (when ordering) to specify a grade of about the fineness of granulated sugar. Successful results can not be assured with a compound containing only part paradichlorobenzene and part inert material, since there can be no certainty of the quantity of the chemical present when used.

THE SAN JOSE SCALE

The San Jose scale is a pest of peach, apple, pear, plum, and other deciduous fruit trees, as well as many other plants. The insect takes its nourishment by sucking the sap from the trees, and in this way it is directly responsible for the death of many peach trees each year. The rupturing of the limbs and branches by a heavy infestation of the San Jose scale causes a pitted, diseased condition of the tree which may result in the exudation of droplets of gum.

This insect is thought to have been brought to America from China. It first made its appearance in the United States at San Jose, Calif., about 1870. It has spread over the entire United States, and has taken its annual toll of fruit trees in all parts of the country.

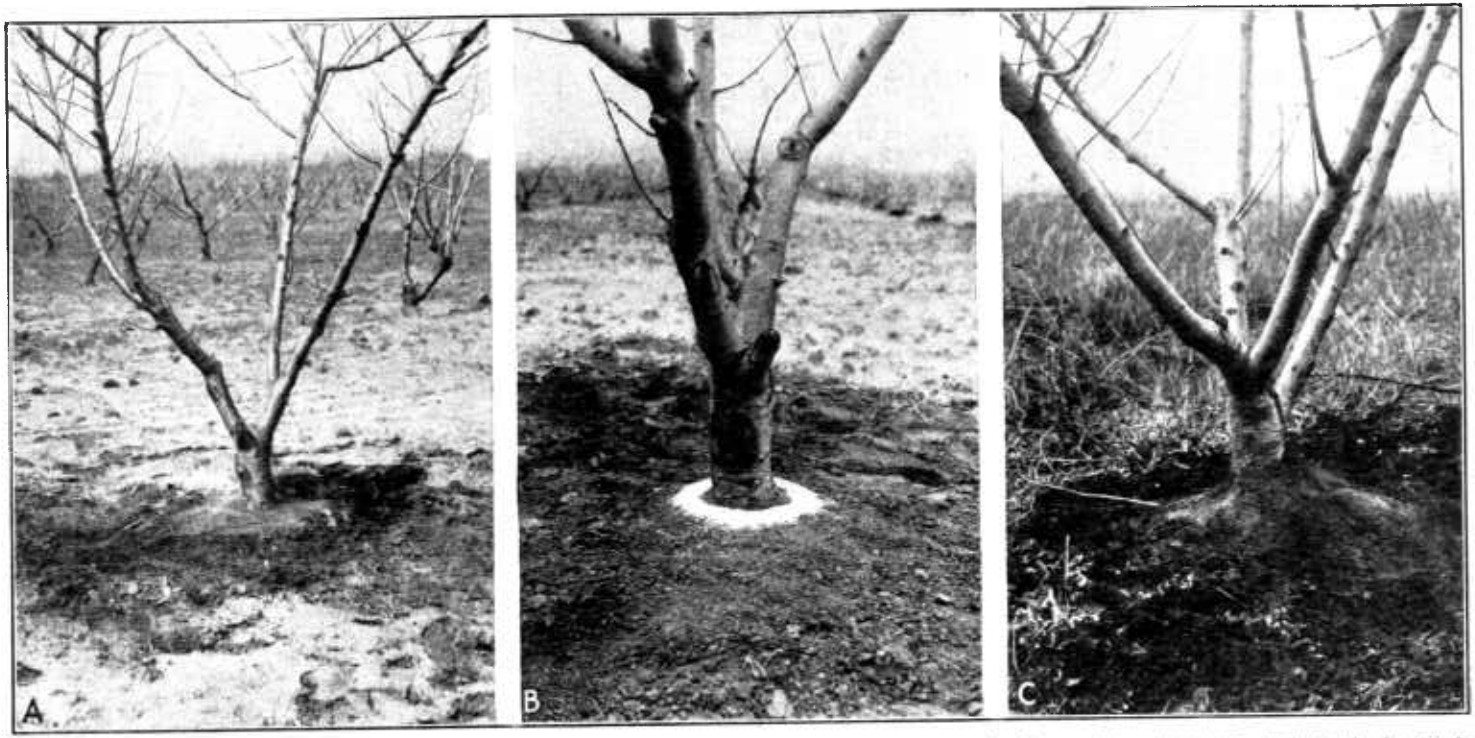

FIG. 10.—Steps in the correct method for treating trees with paradichlorobenzene: A, The soil around this peach tree has been made ready for treatment; B, the ring of crystals should be about 1½ inches wide and 1½ inches from the tree trunk; C, several shovelfuls of soil should be placed on top of the ring of crystals and packed gently with the back of a shovel

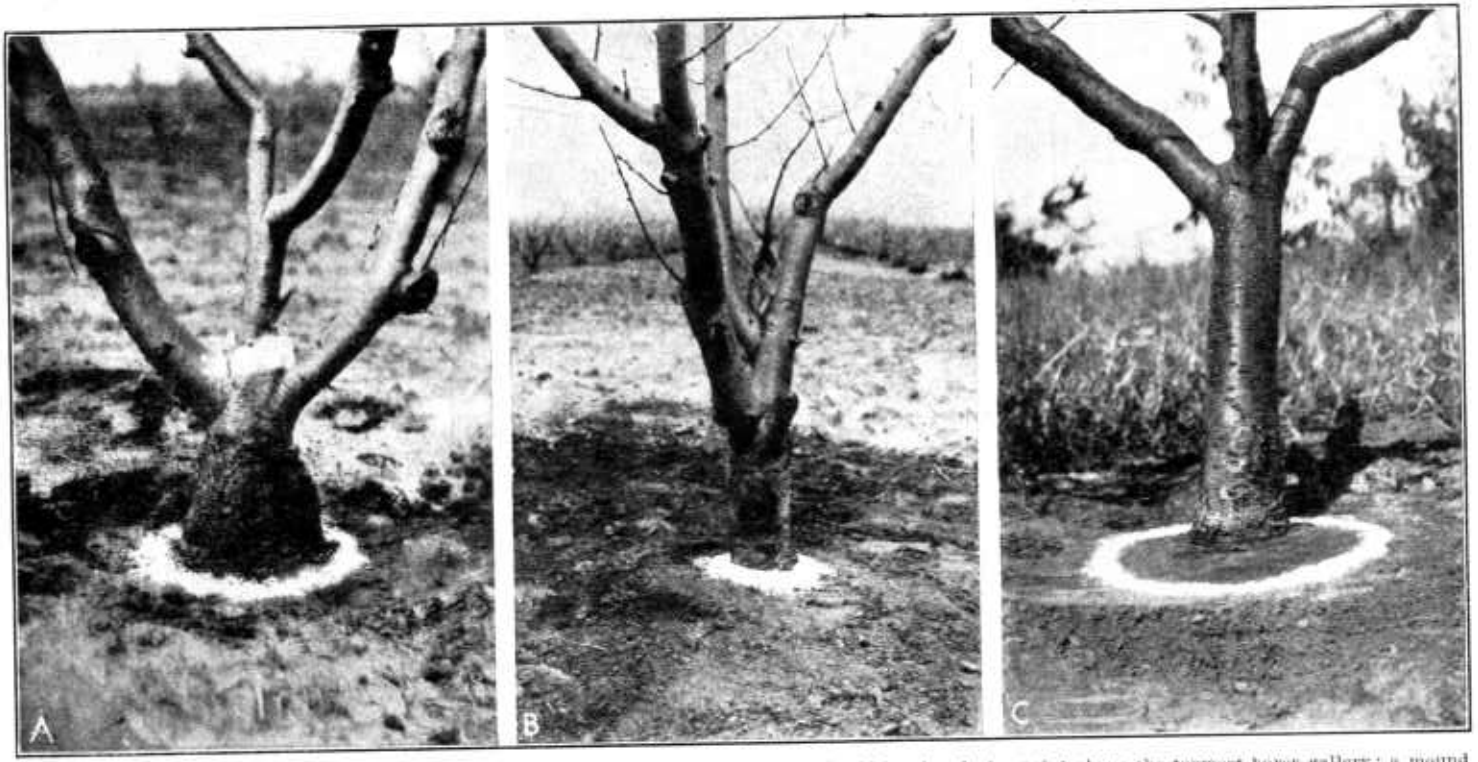

FIG. 11.—Wrong ways of applying paradichlorobenzene: A, The paradichlorobenzene should be placed at a point above the topmost borer gallery; a mound should have been placed around this tree to a point above where the borers are working, so that the crystals could be placed above them; B, if the chemical is placed against the tree trunk, severe injury may result; C, in this case the crystal ring is too far from the tree trunk for effective results

The San Jose scale breeds very rapidly. It has been estimated that the progeny from a single female scale in one season may be over 1,500,000,000 females. In the absence of control measures, a heavy San Jose scale infestation will kill peach trees in several seasons. The first indication of injury to peach trees from this scale is the killing of several limbs or branches. (Fig. 12.) The feeding of the insect will frequently stunt and weaken a peach tree to such an extent that it is especially subject to attacks by other pests which assist in killing it.

The San Jose scale is usually transported from one section of the country to another on nursery stock. Practically all States now enforce laws against the shipment of fruit trees infested by the San Jose scale. Therefore, in buying nursery stock the purchaser should see that the shipment contains a State certificate of inspection

FIG. 12.—Peach tree injured by San Jose scale, several branches having been killed

showing that the trees are apparently free from the San Jose scale. On trees the insect spreads by the young crawling from one branch to another. Birds frequently carry the crawling young on their feet from one tree or locality to another. Certain insects may also carry the crawlers from tree to tree. In all probability man and domestic animals are agencies in the distribution. Winds also doubtless play an important part in the spread of this pest in orchards.

LIFE HISTORY AND HABITS

The full-grown scale has an ashy-gray appearance, and is somewhat convex, with a slightly raised projection in the center. The female is about the size of a pinhead and circular, whereas the male is smaller and elongated. The insect itself is underneath the scale covering. The gray covering is a waxy exudation of the small,

orange-colored, legless insect, which will be found by lifting up the scale covering with the point of a knife. A heavy infestation of the San Jose scale on the bark of peach trees is readily distinguish-

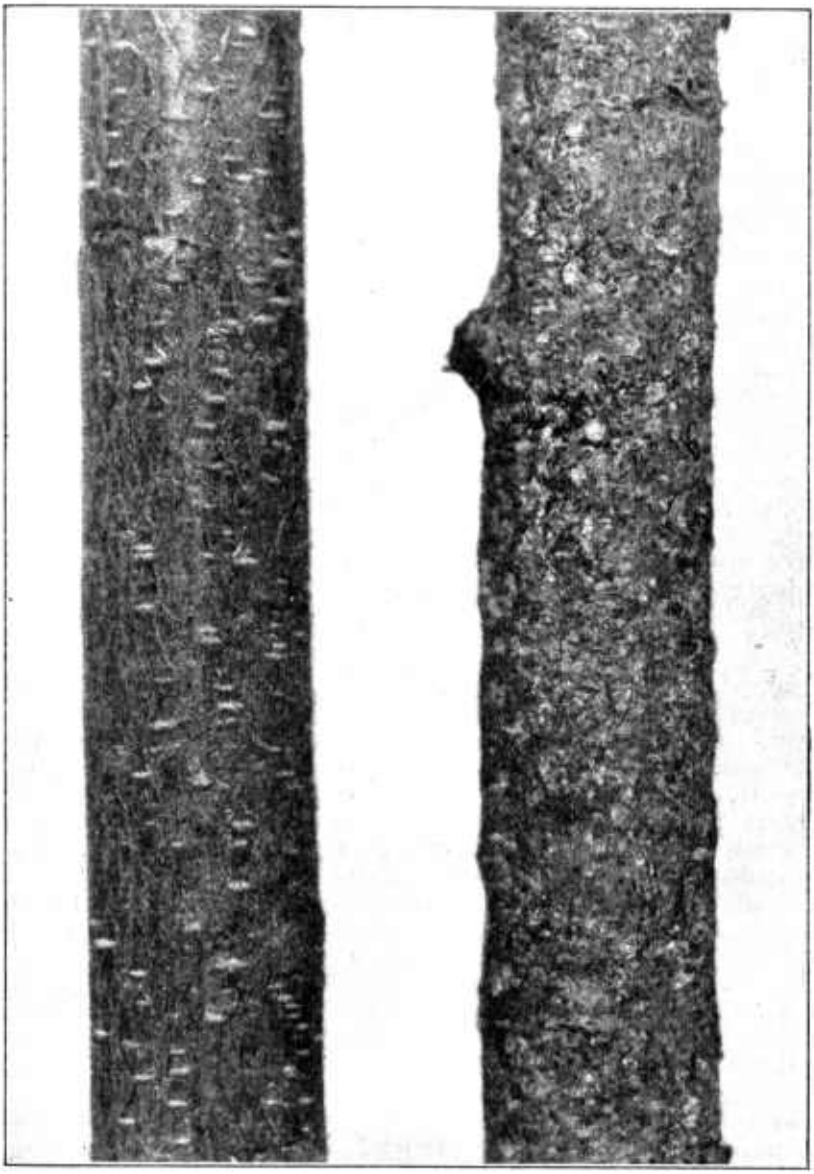

FIG. 13.—Peach twig infested with San Jose scale (right); not infested (left). Twice natural size

able by its grayish appearance (fig. 13), and by the yellow oily secretion when the scales are scraped off with a knife. The insect spends the first few hours after birth as a crawling louse, commonly known as a crawler.

During the normal winter in the South the San Jose scale can be found each month in all stages of development from the crawling young to mature adults. Crawlers have been found each month during a normal winter in the South, showing that reproduction is continuous in that latitude. During an abnormally cold winter in the South, such as 1923–24 when the temperature dropped to zero at some points, practically all of the matured and very young scales are killed, leaving only the half-grown or immature insects. When such weather conditions occur the San Jose scale reproduction is, of course, stopped, and does not continue again until the immature scales are full grown, which is usually during April or May. Upon the emergence of the two-winged active males from the male scales, mating with the females takes place, after which the males die. Within several weeks after the mating date, the females begin to produce young crawlers. These active yellow lice crawl around over the tree looking for a place to attach themselves. When a suitable place is found, which is usually only a few hours after birth, the crawler sends its long threadlike beak into the sap cells of the tree for the purpose of sucking out the sap for food, and never moves thereafter from the place of attachment. The waxy covering begins to develop over the insect as soon as it settles down. Within five or six weeks after birth, the females start to reproduce, having been fertilized by the males, which emerge from three to four weeks after birth. A female scale gives birth to an average of about 400 crawlers. There are perhaps six or more generations annually in the South during years when normal conditions prevail.

CONTROL

Lubricating-oil emulsion applied during the winter when the trees are dormant is an effective control measure for the San Jose scale. Liquid lime-sulphur has also been used against this insect for years, and is reasonably effective under usual conditions. As the insect takes its nourishment by sucking the sap, lead arsenate or other stomach poisons are of no value against it. The spray must be one that will produce death by direct contact with the insect. Therefore, in order to insure a high rate of control with either of the materials mentioned above, a very thorough job of spraying must be done, so that it will hit every side of the trunk, lateral limbs, and branches. The concentration of the spray necessary to produce effective scale control would cause heavy defoliation of the trees if it were used during the growing season; consequently the spraying must be done during the dormant season, when there is no foliage on the trees and when the bud wood is seasoned for winter weather.

Whenever a heavy scale infestation has caused the death of some limbs, they should be removed and the tree pruned, if possible, before the dormant spray is applied. Peach trees that have been devitalized by the San Jose scale should receive a fertilizer high in nitrogen the following spring to force out bud wood. If an incrusted infestation of scale has stunted and greatly weakened a peach tree it would be better to remove it during the winter and replant.

LUBRICATING-OIL EMULSIONS

During recent years lubricating-oil emulsions have come into general use for the control of the San Jose scale on deciduous fruit trees. A weak oil emulsion has been in use for a number of years in Florida against certain citrus insects. A few years ago, when the San Jose scale infestation became serious on apple trees in Arkansas, lubricating-oil emulsions twice as strong as those that had been employed in Florida were used and gave very satisfactory results. Some doubt was felt as to the safety of these emulsions on peach trees, and as a consequence experiments on their use on peach trees were started during the fall of 1922 in Georgia by the Bureau of Entomology. The same trees were treated with the emulsion yearly for five consecutive years, with no discernible injury to the buds, twigs, or collars, and with excellent scale control. Therefore its use with safety on peach trees is reasonably well assured.

Since lubricating-oil emulsion is not caustic it is easier to handle, and since spray men will not be trying to dodge a charge of it, a more thorough job of spraying can be accomplished. Furthermore, it is not so hard on spray machinery, hose, and harness as the caustic sprays. Lubricating-oil emulsions can be used earlier in the dormant season in the South than lime-sulphur, as bud wood before it is hardened by cold weather does not seem to be affected by the emulsion.

A 3 per cent lubricating-oil emulsion is recommended for the control of the San Jose scale on peach trees in the South. It should be used only when the trees are dormant, so as to avoid defoliation. Manufacturers are now placing on the market a concentrated lubricating-oil emulsion containing approximately 66⅔ per cent of oil. To make a 3 per cent emulsion, 9 gallons of such a concentrated emulsion to 191 gallons of water should be used. The concentrated material should not be carried over from one season to another, as most emulsions break down with age, liberating free oil which is injurious to the trees.

Both heated and cold-stirred lubricating-oil emulsions are now being used by peach orchardists for San Jose scale control. Both can be made on the farm somewhat cheaper than the manufactured material can be purchased. The heated emulsion is made from the following formula:

Red engine oil, or oil of similar grade (viscosity 125 to 250 seconds, Saybolt, at 100° F.)	gallons	2
Potash fish-oil soap	pounds	2
Sufficient water added to make total volume	gallons	3

Place the ingredients in a kettle and boil for a few minutes until the brown scum, which forms on the top, has disappeared. Then remove the kettle from the fire and pump the contents twice under at least 60 pounds pressure while still hot. The first pumping can be made from the original container into another container, and the second pumping can be back into the original container or into a barrel. This stock emulsion contains 66⅔ per cent of oil, and to make a 3 per cent emulsion for use on peach trees 9 gallons of it should be diluted with 191 gallons of water.

Some growers prefer the cold-stirred emulsion, as it is easier to make. Apparently it gives as good results as the heated emulsion. The following directions should be followed for making the cold-stirred emulsion:

Add 2 pounds of casein-lime emulsifier with thorough and rapid stirring to sufficient water to make 1 gallon. Pour this mixture, with constant stirring, into 6½ gallons of additional water in a 50-gallon barrel. Then add 15 gallons of red engine oil, or oil of similar grade (viscosity 125 to 250 seconds, Saybolt, at 100° F.). Then place the suction hose in the barrel and start the motor of the spray outfit. When the pressure registers 250 pounds, allow the ingredients to be sucked through the pumps and forced out through one or both spray rods, either with disk removed or with disks having a $\frac{3}{16}$-inch aperture, into another 50-gallon barrel. The emulsion should be passed through the pumps under pressure three times. This stock also contains 66⅔ per cent of oil, and 9 gallons of it to 191 gallons of water is the strength that should be used on peach trees. (CAUTION: In using this formula, do not begin by adding oil to the water, as an emulsion useless for spraying will result.)

Both the home-made heated and cold-stirred emulsions should be used within a week or 10 days after they are made, so as to avoid separation of free oil from the emulsion. If the cold-stirred emulsion breaks down, which is indicated by free oil coming to the top, it can be readily remulsified by pumping.

One thorough application of either emulsion is usually sufficient for satisfactory scale control; however, if necessary, a second application may be used during one dormant season. The soap emulsion should be used with soft water. The casein emulsion can be used with either soft or hard water. If the soap emulsion breaks down in hard water, add ¼–¼–50 Bordeaux mixture to the water before putting in the stock emulsion. Tanks that have been used for lime-sulphur spraying must be thoroughly cleaned before being used for oil-emulsion spraying. Lime-sulphur residue may be removed by running a strong solution of caustic soda through the pumps and by scrubbing the inside of the tank with caustic soda. Examine the stock emulsion for free oil before and after adding water, as free oil indicates that the emulsion is unfit for use and should be discarded or repumped. Never let the stock emulsion freeze (it will freeze at about 15° F.).

LIME-SULPHUR SOLUTION

Lime-sulphur solution is one of the oldest remedies for the San Jose scale on deciduous fruit trees. It has long been considered very effective against the insect, but recent experiments have shown that as a scale treatment it is less effective than lubricating-oil emulsions. It has fungicidal properties, however, which emulsions do not have. Liquid lime-sulphur should never be applied in the South until after two or three killing frosts have occurred, if injury to bud wood is to be avoided. Lime-sulphur may injure new-growth peach wood in the South if it is applied before the wood has been subjected to cold weather. (Fig. 14.) If the scale infestation is heavy, a second application of liquid lime-sulphur may be necessary in the spring before the buds burst.

For years insecticide manufacturers have had on the market concentrated lime-sulphur solutions which need only to be diluted with water for scale spraying. These concentrates usually have a density of 32° or 33° Baumé, and should be used at the rate of 1 part of the

concentrate to 7 parts of water for the control of the San Jose scale on peach trees.

The lime-sulphur concentrate may be made on the farm somewhat cheaper than the manufactured material can be purchased. Directions for preparing lime-sulphur concentrate on the farm are given in Farmers' Bulletin No. 1285.[21]

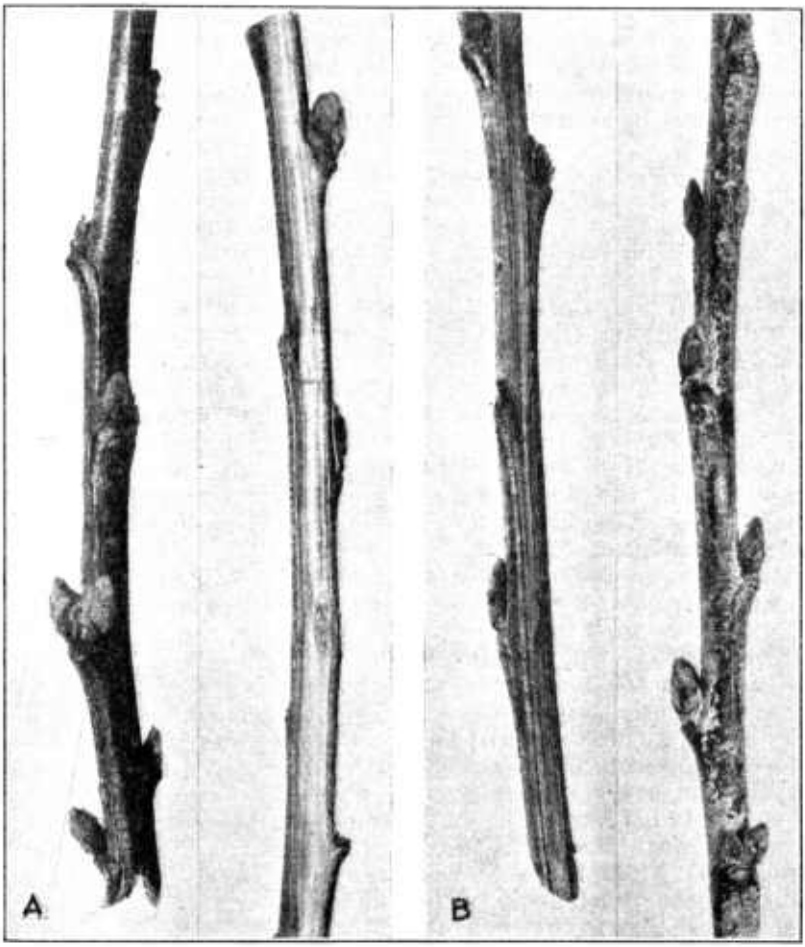

FIG. 14.—Peach bud wood killed by applying liquid lime-sulphur too early (right); uninjured bud wood (left)

COMPARATIVE COST OF SPRAYS

In Georgia the liquid lime-sulphur costs about 15 cents per gallon, f. o. b. shipping point. Therefore, the 1 to 7 lime-sulphur dilution costs about $3.75 per 200 gallons of diluted spray. Lubricating-oil emulsions can be purchased from manufacturers for about 25 cents per gallon. Used at the rate of 9 gallons to 191 gallons of water (to

[21] SIEGLER, E. H., and DANIELS, A. M. LIME-SULPHUR CONCENTRATE: PREPARATION, USES, AND DESIGNS FOR PLANTS. U. S. Dept. Agr. Farmers' Bul. 1285, 42 p., illus. 1922.

form a 3 per cent oil spray), the cost would be around $2.25 per 200 gallons of diluted emulsion. Both of these sprays can be made on the farm for less than the figures given above.

MISCIBLE OILS

Miscible oils, which are usually made from petroleum oils, soap, and a third substance, such as cresylic acid, to make the soap soluble in the oil, are sold under several proprietary names for San Jose scale control. Injury to young twigs has been noted at times from the use of miscible oils on peach trees in the South, and therefore they may not be as safe as the two sprays recommended above.

THE ORIENTAL PEACH MOTH

The oriental peach moth was not known to occur in the Southern States until the fall of 1923, when several larvae were detected in peach twigs from the home orchard of R. M. Shaw, Valdosta, Ga. During the following year the insect was found at other points in Georgia, including the peach belt, and in the States of North Caroline, Florida, Alabama, Mississippi, Tennessee, Arkansas, and Texas, and typical injury was found in South Carolina and Louisiana. The insect was brought into the United States from Japan about 1913, and shortly thereafter infestations were found in the District of Columbia, Maryland, and northern Virginia. Before it became established in the South it had spread to a number of Northern States. It is believed that the oriental peach moth was brought to the South in infested apples.

The larva, or worm, of the oriental peach moth damages both the twigs and fruit of the peach. During the spring and early summer, when the new growth of peach trees is tender, the larvae enter the new twigs at the tip, near the base or the axil of a leaf, and eat out the center of the twig as they work downward. (Fig. 15.) One larva may enter several twigs before it becomes mature. Heavy infestations of the oriental peach moth may cause a tree to take on a bushy appearance, on account of the growth of the secondary shoots when new terminal growth is destroyed early in the season. When the twigs harden in midsummer, the larvæ cease to work in them and start feeding in the fruit. (Fig. 16.) They enter the fruit either from the side, near the stem, or through the stem. Injury to the peach fruit by larvae of the oriental peach moth is somewhat similar to that produced by curculio larvae; however, full-grown peach moth larvae are usually pink, whereas curculio larvae are of a creamy-white color.

At present the oriental peach moth infestation is very light in the localities of the South where the insect is known to occur. Up to the present the insect has not been of economic importance in this region of the United States. The chances are that it never will be a pest of major importance in the southern peach sections where there is no late fruit for the maturing of the last three broods of larvae, the ones that normally pass the winter in hibernation. In the central Georgia peach belt the harvest of the latest commercial variety of peaches is usually completed before the last three broods of the

oriental peach moth have been produced. By that time the larvae have ceased to work in the twigs on account of their hardened condition. Consequently there is an apparently heavy mortality of larvae of broods that would enter hibernation, owing to the absence of

FIG. 15.—Peach-tree twigs injured by oriental peach moth larvae. (Wood and Selkregg)

suitable food after midsummer. Dead larvae have been found frequently in peach twigs in Georgia after peach harvest, their death apparently having resulted from an inability to feed in the hardened twigs.

LIFE HISTORY AND HABITS

The oriental peach moth passes the winter as a larva, or worm, in a cocoon. In the latitude of central Georgia the larvae start to change to pupae during the latter part of February. The insect remains in the pupal state from 8 to 12 days. (The pupal period of the spring brood may last much longer.) Eggs are being deposited by spring-brood moths during full bloom of Georgia peach trees.

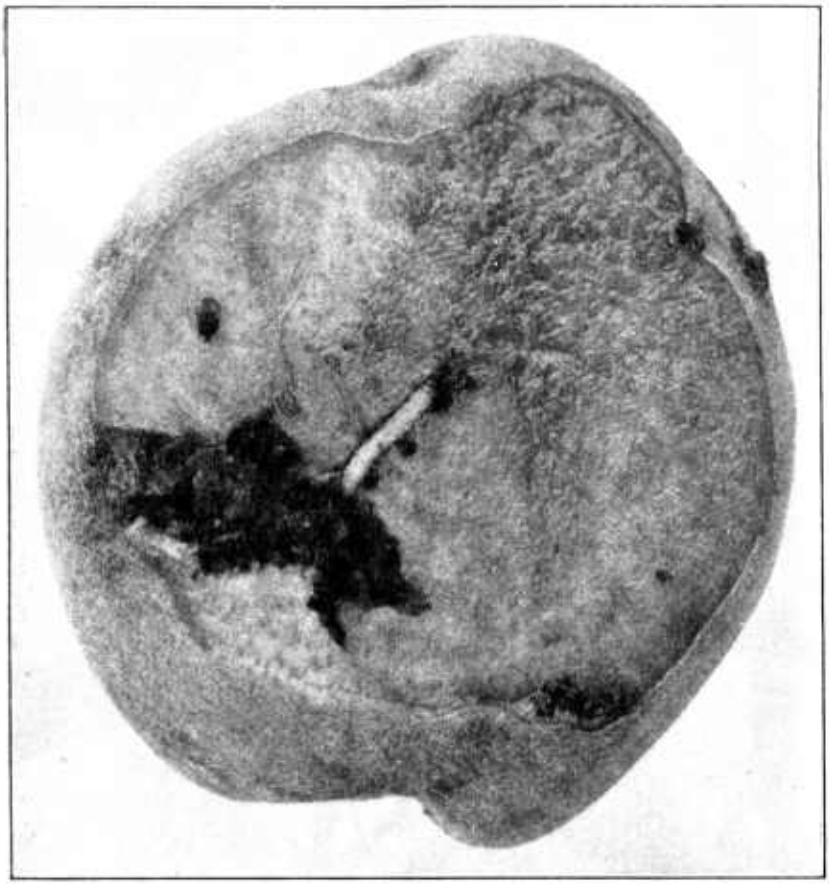

FIG. 16.—Larva of oriental peach moth working in peach. About twice natural size. (Quaintance and Wood)

The egg production per female averages about 40. A single female moth has been known to deposit over 200 eggs. The eggs are deposited chiefly on the under side of peach leaves. The eggs hatch in from 3 to 10 days under southern conditions. The larvae feed in the twigs of peach trees while they are tender, or in the fruit. The larval feeding period averages about 10 days in the summer. From 2 to 4 days on the average are spent by the larvae in constructing cocoons after they leave the host, and while they are in the prepupal stage.

There are six or seven generations annually in the South. At Fort Valley, Ga., six generations and a partial seventh were reared in the insectary in 1925, and five generations and a partial sixth were reared in the insectary in 1926. In 1925 the first moth of the spring brood emerged on March 8, and the last moth of the sixth brood emerged October 25. There was considerable overlapping of the emergence periods of the last four broods of moths in 1925. In 1926 the first moth of the spring brood emerged on March 28, and the last moth of the last brood emerged on September 27. There was a distinct overlapping of the emergence periods of all broods of moths in 1926. In 1927 the first moth of the spring brood emerged on February 23. In 1925 fourth-brood larvae were making their appearance in the Georgia peach belt during the harvest of Elberta peaches, the last commercial variety to ripen in that State. No larvae of the fourth brood hibernated in 1925. The fifth, sixth, and seventh generations were reared after the peach harvest that year, and 13 per cent of the fifth, 65 per cent of the sixth, and 100 per cent of the seventh brood of larvae hibernated. In 1926 third-brood larvae were making their appearance in the Georgia peach belt during the harvest of the last commercial variety of peaches. No larvae of this generation hibernated. The larvae that hibernated in 1926 were individuals of the fourth, fifth, and sixth broods. Thus the broods of peach-moth larvae that hibernate in central Georgia are not produced until after the fruit has been harvested, and when the twigs have become too hard to be a host for them.

CONTROL MEASURES

Mortality of oriental peach moth larvae of the broods that hibernate in the lower South, owing to the absence of host plants in any numbers after midsummer, may always keep the infestation down to a point where the enforcement of control measures will not be necessary. As the larva of this insect discards the first several mouthfuls of food and does not start to feed until its head is embedded in the fruit or twig, the control of the oriental peach moth presents a very difficult problem. At present no very satisfactory means of control have been found. Thorough spring cultivation reduces the infestation early in the season. Picking up and destroying dropped fruit infested with the larvae would reduce the number of larvae that hibernate. The clipping and burning of infested twigs early in the season may reduce the infestation. Paradichlorobenzene, as used for the control of the peach borer, has been recommended for the control of larvae hibernating in cocoons on the trunks of peach trees near the ground. Bait pans in peach orchards to attract and catch the adult moths have been suggested, but under conditions in the South this method has not been successful or practical.

THE SHOT-HOLE BORER

The shot-hole borer or fruit-tree bark beetle occurs throughout the South, attacking chiefly fruit trees that have been devitalized by some other pest or injured and weakened by some other condition. Occasionally they attack healthy trees that are near diseased ones, which have furnished excellent breeding quarters for the

insect. Both the larva and adult beetle burrow into the bark of peach trees. Many small, round entrance and exit holes in the bark of attacked trees reveal the presence of the insect (fig. 17), and frequently growers attribute the unhealthy condition of their trees to these insects, whereas they are only secondary pests working in trees that have been rendered unhealthy by some other cause.

FIG. 17.—Peach limb attacked by the shot-hole borer; gum exuding from holes made by the insect. (Brooks)

LIFE HISTORY AND HABITS

In the spring the small black beetles appear on unhealthy peach trees and eat out a channel between the bark and cambium layer, in which eggs are deposited by the females in small notches. The eggs hatch in several days, and the larvae feed for about a month in burrows under the bark before they begin to pupate. The pupal stage continues for about a week, when the resulting adult beetle escapes through a small exit hole. Soon after emergence the beetles begin to deposit eggs for another generation. There are three or four generations each year in the South. The winter is passed in the larval stage.

CONTROL

The shot-hole borer seldom feeds and breeds in healthy trees, but confines its attack mostly to trees that have been weakened by the San Jose scale, borers, crown gall, winter injury, mice, rabbits, or neglect and starvation. Therefore the elimination of breeding quarters is the most important factor in the control of this insect. Peach trees that have been seriously devitalized should be pulled up and burned. When only a limb or two is affected it should be removed and the tree strengthened by fertilizers and cultural methods. Wild fruit trees and seedlings that may be furnishing breeding places for the insect near an orchard should be removed. Prunings should not be allowed to remain on the ground in an orchard very long after they are cut, as the insect might breed in them.

Peach trees that are infested with the shot-hole borer may be saved by applying a thick coat of whitewash (fig. 18), after the severely infested limbs have been removed, and by heavy fertilization to stimulate the tree. In cases of very heavy infestations the application of thick whitewash should be repeated two or three times during the year.

THE LESSER PEACH BORER

The lesser peach borer confines its attack to the trunk of peach trees, mostly above ground. Only injured or diseased trees are

FIG. 18.—A thick coat of whitewash applied to a peach tree heavily infested with shot-hole borers. (Brooks)

attacked, and the insect is invariably found working in areas on the trunk or limbs that have been injured by implements, cankers, low temperatures, or sun scald, and in crotches or under loose bark of

old trees. (Fig. 19.) Frequently this insect has been confused with the peach borer (p. 8), on account of the similarity of the larvae and adults. The lesser peach borer occurs in all of the Southern States.

FIG. 19.—Trunk of an old peach tree heavily infested with larvae of the lesser peach borer. (Girault)

LIFE HISTORY AND HABITS

Like the peach borer, the lesser peach borer passes the winter in the larval stage. During late winter or early spring in the South the overwintered larvae change to pupae. The pupal stage lasts from three weeks to one month, when the adult moths emerge. The eggs are deposited along the trunk of the tree, and the incubation period is about one week. Larvae of the summer brood reach maturity within several months, then form pupae, from which come the second-brood moths. The larvae from eggs of second-brood moths hibernate during the winter. Therefore, two generations of the lesser peach borer occur annually in the latitude of central Georgia.

CONTROL

Preventive measures should be employed, as the only available remedy for the lesser peach borer after it has attacked a tree is to dig the larva out and kill it. As the insect attacks injured or diseased areas on the trunk and branches, care should be exercised not to scrape, bark, or otherwise injure the trees with implements while cultivating. Wounds on peach trees should be given prompt treatment, and the trees should be kept in a clean and healthy condition by proper orchard management and fertilization. Limbs broken during peach harvest or killed by low temperatures during the winter should be promptly removed. Cankers and areas killed by

sun scald should be cut out before they become infested with the lesser borer.[22]

After the trees have become infested, the only remedy is "worming." This should be done in the fall and spring, when all parts of the trunk and lower limbs should be examined for the larvae. In cutting them out it will be necessary frequently to cut away considerable bark and rough and diseased areas. All such areas and wounds should be thoroughly cleaned out and treated with lime-sulphur or other antiseptic wash. Sprays and washes are of little or no value for the control of the lesser peach borer.

GRASSHOPPERS

Occasionally grasshoppers of several species attack peach trees and feed on the little peaches or foliage. It is not uncommon to find the largest winged grasshopper [23] feeding on half-grown peaches in Georgia orchards. In some cases the entire peach is devoured, while in others the light feeding causes a gnarly condition of the fruit when it is ripe. Other species of grasshoppers, such as the red-legged grasshopper [24] and the differential grasshopper,[25] sometimes feed on the foliage of peach trees, causing considerable damage. During droughts, when there is very little green vegetation to feed on, grasshoppers may almost defoliate peach trees.

LIFE HISTORY

During the fall, grasshoppers lay their eggs in masses below the surface of the soil. The eggs are yellow and are arranged irregularly together and covered with a gluey material. The winter is passed in the egg stage. The young grasshoppers, or nymphs, hatch in the spring, usually during April and May in the South, and start immediately to feed on whatever crops are available. They reach maturity during the summer and lay their eggs during the fall months.

CONTROL

Poisoned-bran mash is regarded as the most effective means of controlling grasshoppers, and it is now perhaps more extensively used than any other means of control. The poisoned mash is placed around in the orchard where the insects have been working, late in the evening or early in the morning. The mash is made as follows:

Bran	pounds	50
Sodium arsenite	do	1
Low-grade molasses	gallon	1
Water	do	6

The sodium arsenite and bran are first mixed together while dry. The molasses is then dissolved in the water and added to the previously mixed dry sodium arsenite and bran and stirred thoroughly. The mixture should be used at the rate of 10 pounds (wet weight) per acre.

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[22] For further information on the treatment of the wounds and other injuries of trees, see Farmers' Bulletin 1178, "Practical Tree Surgery," by J. Franklin Collins.

[23] *Schistocerca americana* Scud.

[24] *Melanoplus femur-rubrum* DeG.

[25] *Melanoplus differentialis* Thos.

A spray of lead arsenate at the rate of 1 pound of the powder to 50 gallons of water, with the milk of lime from 3 pounds of unslaked lime, will give some protection to peach trees from grasshoppers.

As the eggs are laid in the ground, plowing or disking in the orchard, before the hatching season, will either destroy many or bury them too deep for the young nymphs to emerge. Hopperdozers are sometimes used to catch the young hoppers. The hopperdozer consists of shallow pans containing kerosene, on a frame mounted on runners or wheels, and provided with a high back and sides made of canvas. It is pulled between the tree rows, and the hoppers are killed as they hop into the pans containing kerosene.

THE PEACH-TWIG BORER

The peach-twig borer occurs throughout the southern States, but it seldom does much damage. The larva, or worm, injures the twigs and fruit of peach trees in much the same manner as does the oriental peach moth. (Figs. 15 and 16.) This has caused alarm at times when the injury from this minor peach pest has been confused with that of the oriental peach moth. Occasionally the twig injury from the peach-twig borer is rather heavy, resulting in killing or stopping the growth of shoots early in the spring.

LIFE HISTORY

The life history of the peach-twig borer is similar in some respects to that of the oriental peach moth. It passes the winter as a small larva in a silk-lined cavity under loose bark, in crotches, in cavities in the trunk, and similar places. These larvae emerge in the spring and attack the new tender shoots, which soon wilt and die. When full grown the larvae construct loosely woven cocoons on the larger limbs or trunk, in which pupation takes place. The pupal stage lasts from 8 to 12 days, when the adult moths emerge. The eggs are deposited on the new twigs or directly on the fruit, and they hatch in about 5 days. From 8 to 12 days are required for the larvae to reach maturity in midsummer. The mature larvae have a reddish-brown or chocolate color, which distinguishes them from oriental peach moth larvae, which are pink to red in color. There are four or more generations annually in the South.

CONTROL MEASURES

Spraying, just as the buds show pink, with either lime-sulphur solution at the rate of 1 part of the concentrate to 10 parts of water, or lead arsenate at the rate of 1½ pounds of powder to 50 gallons of water, has been recommended for the control of the peach-twig borer. The clipping and burning of infested twigs during the summer and the burning of brush removed during the winter pruning will lessen injury from this insect.

THE CORN-EAR WORM

The corn-ear worm occurs throughout the South and is primarily a pest of corn, tomatoes, tobacco, cotton, and legumes. On vetch and

other legumes it feeds in colonies, and when these crops are not turned under early enough, are left for seed, or are cut late, the worms assume the army-worm habit and move in "armies" to adjacent peach orchards or fields of other crops. Because of this habit corn-ear worms are sometimes confused with army worms. In 1926 corn-ear worms did considerable damage to peaches and other crops in Georgia, Alabama, and South Carolina. Considerable vetch was grown in the South that year, and peach orchards adjoining fields in which vetch was not turned under soon enough or allowed to go to seed were materially damaged by the worms devouring the green peaches as they marched across them. The damage occurred from

FIG. 20.—Furrow in cornfield to protect it from the corn-ear worm. This is the kind of furrow that should be used in protecting peach orchards. Note posthole to trap the worms. (Luginbill and Beyer)

the middle of May to the first part of June. In one orchard in southern Georgia the corn-ear worms practically destroyed the crop of peaches on 4,000 young trees. In this case vetch had been planted between the tree rows and the grower had failed to turn it under early enough. In another case the worms attacked a peach orchard from hay in a near-by barn, where they had hatched after the hay was cut and stored.

The entire life cycle of this insect requires 35 or 40 days during the summer months. Only larvae, or worms, of the first generation attack green peaches in the South. These hatch during May and June. There are four generations annually in the South.

CONTROL MEASURES

When the insect assumes the army-worm habit and starts marching from vetch fields toward peach orchards it can best be prevented from injuring the peaches by constructing a deep furrow around the orchard or in the path of the advance of the worms. (Fig. 20.) This furrow can be made with a turn plow or ditching machine. One side should be steep, and postholes should be provided at intervals to entrap the worms. (Fig. 20.) This method of protecting peach orchards that are threatened by the insect has been used successfully in Georgia. Poisoned-bran bait, such as described for use in grasshopper control, broadcasted in the orchard, or spraying or dusting with lead arsenate, is recommended after the worms get into an orchard. The lead arsenate should be used at the rate recommended for the control of the plum curculio.

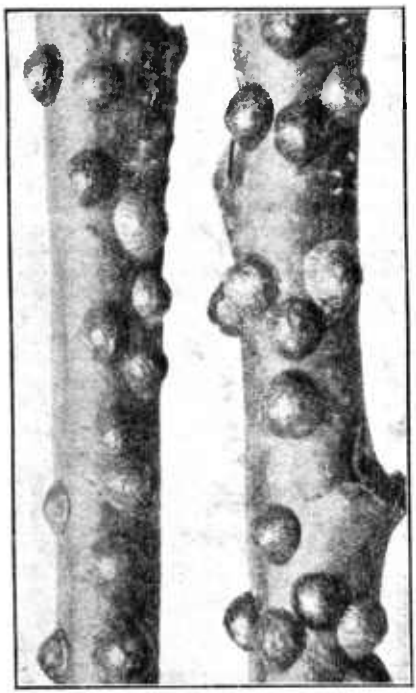

FIG. 21.—The terrapin scale on peach twigs. About twice natural size. (Quaintance and Siegler)

THE TERRAPIN SCALE AND WEST INDIAN PEACH SCALE

The terrapin scale or peach lecanium (fig. 21) has been found on fruit trees in each of the Southern States, although it is seldom a pest of major importance. Its presence is indicated by the sooty condition of the twigs and leaves caused by a fungous growth on the honeydew excreted by the insect. This sooty fungus renders the fruit unmerchantable. The insect injures the tree in a manner similar to that of the San Jose scale, although it seldom directly causes the death of the tree. The scale covering resembles somewhat the shell of a terrapin; it varies in color from black to red and has a somewhat ridged edge.

The West Indian peach scale, or white peach scale as it is sometimes called, has been found in a number of localities in the South, and, as a peach-tree pest, it is sometimes as injurious as the San Jose scale. Some years ago the West Indian peach scale caused considerable injury to peach trees in the vicinity of Natchez, Miss. The females are circular and of a brownish-white color. The males, which usually occur in clusters, are elongated and pure white. There are four or five generations annually in the South.

CONTROL MEASURES

Lubricating-oil emulsion, 12 gallons of the stock solution to 188 gallons of water, applied as recommended for the control of the

San Jose scale, is recommended for the control of the terrapin scale. A 3 per cent strength of oil will doubtless be effective against the West Indian peach scale. The emulsion should be applied during the winter, while the trees are dormant. Lime-sulphur has been used successfully against the West Indian peach scale, but it is apparently ineffective against the terrapin scale.

SQUASH BUGS

Several species of the squash-bug family have been known to attack peaches in the South, and in some instances they have caused considerable damage. The species most commonly found attacking peaches is known scientifically as *Leptoglossus oppositus* Say. These

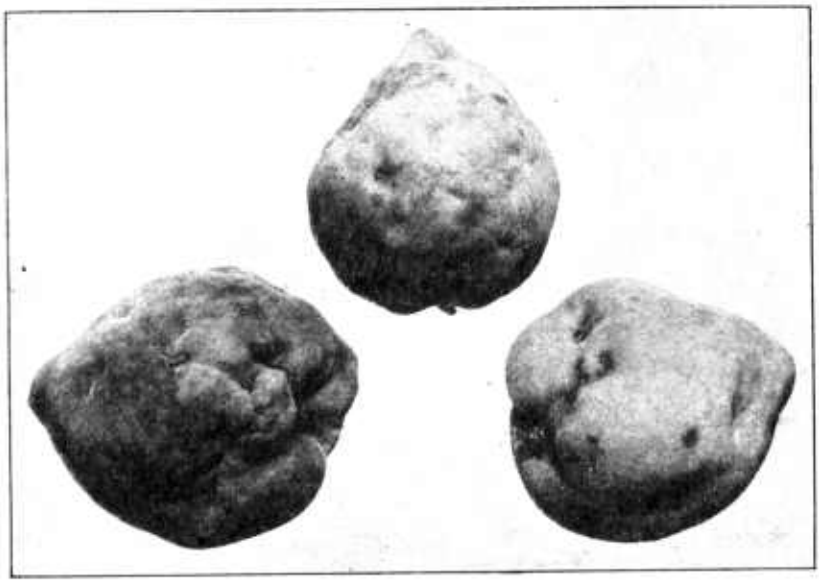

FIG. 22.—Ripe Hiley peaches showing effect of attacks by a member of the squash-bug family, *Leptoglossus oppositus*, several months before

insects pierce the green peaches with their beaks and then suck out the sap for food. They have been found with the beak inserted into a peach to a depth of one-half inch. This feeding early in the season causes the fruit to become knotty and ill-shaped by harvest. (Fig. 22.) The attacks on peaches are usually made by adults, but nymphs, or young bugs, also have been found feeding on them. This insect passes the winter as an adult. There are several generations annually.

CONTROL

Hand picking is the most satisfactory means of control. Nicotine-sulphate spray at the rate of 1 pint to 50 gallons of water with a little laundry soap will control the nymphs, or young bugs, but will not kill the adults. The adults can be trapped under boards or stones placed close to where the insects are working.

SOUTHERN GREEN PLANT BUGS

Southern green plant bugs are also known as stinkbugs or pumpkin bugs. They can be easily recognized by their odor. Injury to peaches in the South sometimes results from these bugs sucking the sap out of the fruit from shortly after it sets until it ripens. When southern green plant bugs attack green peaches that are half grown or less, the ripening fruit will often be gnarly or knotty, much as is that attacked by members of the squash-bug family. When the infestation is heavy, nymphs, or young bugs, of all sizes may also be found attacking peaches. This insect passes the winter in the adult stage. There are several generations annually, which may overlap.

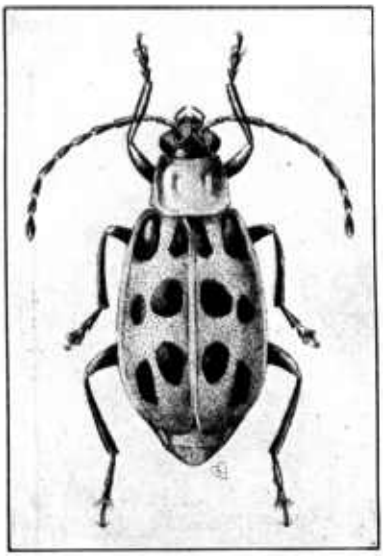

FIG. 23.—The spotted cucumber beetle. About seven times natural size

CONTROL

Climatic conditions and parasites usually hold the southern green plant bug in check. It usually occurs in injurious numbers only after mild winters, and since it is attacked by several parasites its occurrence as a fruit pest is only occasional. No spray has yet been developed that can be used efficiently against the adults. Nicotine sulphate at the rate of 1 pint to 50 gallons of water with soap is fairly effective against the young bugs or nymphs.

THE SPOTTED CUCUMBER BEETLE

The spotted cucumber beetle (fig. 23) is sometimes an injurious pest in southern peach orchards. By the time peach trees are in full bloom in the spring these beetles are out in numbers and begin feeding on the calyxes of the peach flowers, in many cases eating through them and devouring the little peaches which have just set. Orchards near cornfields and gardens are especially subject to attacks from these insects. The beetles may also feed on the tender leaves of nonbearing peach trees during the spring and early summer. Attacks in nonbearing orchards have been known to be severe enough to warrant the use of control measures.

LIFE HISTORY

The spotted cucumber beetles pass the winter in the adult stage, hibernating in grass and other vegetation in and near the orchards. They usually make their appearance in Georgia during March, when they attack the peach flowers, devouring the calyxes and little peaches. Egg deposition starts in April. The eggs are laid just under the surface of the soil. The incubation period varies from about two weeks early in the season to less than one week later on.

Within a month the larvae become full grown and pupate. Adults of the first generation make their appearance in the South during May and June. There are several generations annually.

CONTROL

Lead arsenate, as used for the control of the plum curculio, apparently either repels the spotted cucumber beetles on peach trees or kills many when they feed upon the poisoned flowers and foliage. Application of lead arsenate in the proportion of 1 pound of the powder to 50 gallons of water, with the milk of lime from slaking 3 pounds of stone lime, or from 4 pounds of hydrated lime, has proved effective in stopping attacks by this insect on bearing peach trees. This treatment is also effective against the insect attacking tender foliage of nonbearing peach trees.

BLISTER BEETLES

Blister beetles are primarily pests of vegetables. However, one species [26] attacks the foliage and blossoms of peach trees. These beetles are slender in form, about one-half inch long and three-sixteenths inch wide, rather soft bodied, and varying in color from brown or bronze to a metallic green. They are greedy feeders, traveling in the army-worm manner, or in swarms, eating almost every kind of vegetation. When they get into a peach orchard they strip the trees of foliage and blossoms. A large swarm of blister beetles has been known to devour all of the blossoms and foliage on 50 trees in a Georgia peach orchard. This injury occurred about the middle of March.

CONTROL

For the control of blister beetles on peach trees, lead arsenate at the rate of 1 pound of the powder to 50 gallons of water, with the milk of lime from 3 pounds of unslaked lime, is recommended. This treatment, combined with jarring the insects on to a sheet, has been used successfully in Georgia, checking a severe outbreak within two days.

THE TARNISHED PLANT BUG

Peach nursery stock in the South is sometimes attacked by the tarnished plant bug, which punctures the terminal buds and tender growing tips in sucking out the plant juices for food. This causes the terminal buds and tips to turn brown, wither, and die, and the tree then develops a bushy form. Injury to peach nursery stock by this insect may easily be confused with that caused by the oriental peach moth.

No satisfactory control for this insect on peach nursery stock has been found. Peach-tree nurseries and surrounding areas should be kept free from weeds, as certain weeds harbor this insect.

THE GREEN JUNE BEETLE

The green June beetle, commonly known as the "June bug," is sometimes troublesome in southern peach orchards. It may appear

[26] *Pomphopoea aenea* Say.

in large numbers about the time that the fruit is ready to be harvested, when it cuts through the skin and feeds on the inside.

As this beetle usually does not become troublesome until the fruit starts to ripen, poisonous sprays can not be employed as a means of control. Continuous hand picking of the beetles is recommended as a protection to the peach crop, and manure piles should not be allowed to remain near an orchard, as they offer excellent breeding conditions for the insect.

THE RUSTY-BROWN PLUM APHID

The rusty-brown plum aphids occur in all of the Southern States, and are present each year, doing more or less damage to the foliage of plum and young peach trees shortly after they put forth leaves. They are more common in home orchards that are not sprayed for other pests in the spring of the year. In central Georgia they usually damage plum and peach foliage from March to May. This louse is of a dark rusty-brown color. It occurs in great numbers and causes the new foliage to become distorted and crumpled by sucking out the food material. The pest may cause the terminal buds of the plum and young peach trees to become so stunted that growth ceases. A heavy infestation may kill the blossoms and prevent fruit from setting.

LIFE HISTORY

The eggs, which were deposited on the small twigs the previous fall, begin to hatch about the time the buds open. The first generation are all wingless females, or stem mothers, which give birth to living young that develop into wingless females. The first several broods are wingless, but later winged forms are produced that migrate to several varieties of grasses and there breed during the remainder of the summer. As cold weather approaches in the fall, winged forms return to the plum and young peach trees and produce wingless females, which are almost black, and these deposit the winter eggs on small limbs.

CONTROL

As soon as the insect appears, spray with nicotine sulphate at the rate of three-fourths of a pint to 100 gallons of water, adding 3 pounds of soap, or a little casein-lime emulsifier, to each 100 gallons of spray to make it stick and spread better. This spray will not be fully effective if the application is delayed until after the leaves curl badly. It is said that lime-sulphur, as used during the winter for the San Jose scale, will destroy the eggs of the rusty-brown plum aphid.

SPRAYING AND DUSTING OUTFITS

For spraying a few peach trees around the home, or in a small home orchard, a bucket spray pump may be used. This should be made of brass or some other metal that will not corrode. A good type of bucket spray pump is shown in Figure 24; however, this should be equipped with a 4-foot extension rod and at least 15 feet of hose.

For spraying orchards of up to 400 or 500 trees, a barrel spray pump (fig. 25) will be found satisfactory. This fits into a 50-gallon

barrel and develops 125 to 150 pounds pressure. It should be equipped with a 4-foot extension rod and at least 25 feet of hose.

The double-acting hand spray pump, which will develop from 150 to 200 pounds pressure, is sometimes used in peach orchards of 5 to 10 acres. This is more costly than the barrel outfit, but much cheaper than a power sprayer. It will develop sufficient pressure for two leads of hose. The chief objections to this outfit are the man power required to operate it and the lack of proper agitation.

The power spray outfit (see title-page) is the most satisfactory, useful, and convenient type of sprayer. It may be purchased in various sizes, and should be used in peach orchards of 10 acres or over. It will develop from 150 to 300 pounds pressure, depending on the power of the motor, and will deliver from 5 to 15 gallons of spray per minute. It is usually equipped with a 200-gallon spray tank, and two leads of hose 35 feet long should be provided.

For dusting a few peach trees a hand duster, consisting of a cylinder with piston rod for making an air blast, may be used. Larger hand dusters in which a fan is operated by cogs or belt from a crank will be found more satisfactory and durable for dusting a few trees or a very small home orchard by hand.

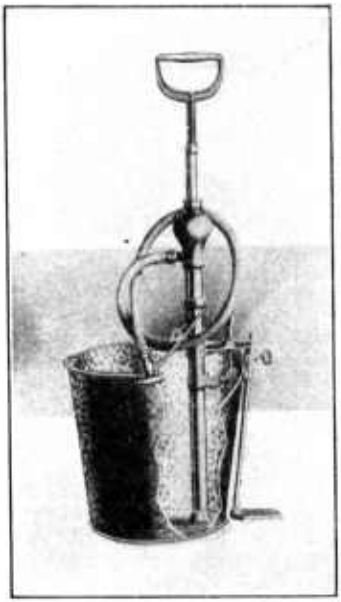

FIG. 24.—Bucket pump for spraying a few peach trees. This outfit should be equipped with a 4-foot extension rod and at least 15 feet of hose. (Quaintance and Siegler)

For dusting commercial or large home orchards a power duster outfit (fig. 26) should be employed. These outfits are driven by a 3 or 4 horse-power gasoline engine, and can be regulated so as to discharge the desired quantity of dust.

INSECTICIDES

LEAD ARSENATE

Lead arsenate is the standard insecticide for chewing insects. It may be purchased in either the powder or paste form, but the powder is preferred. In this bulletin it is recommended for the control of the curculio, grasshoppers, peach-twig borer, corn-ear worm, spotted cucumber beetle, and blister beetles. On peach trees, powdered lead arsenate is used at the rate of 1 pound of the powder to 50 gallons of water, with the milk of lime from slaking 3 pounds of unslaked lime or from 4 pounds of hydrated lime. The milk of lime is used to reduce burning by the lead arsenate. Powdered lead arsenate should be made into a thin paste with water before adding to the spray barrel or tank containing the required quantity of water.

NICOTINE SULPHATE

Nicotine sulphate is the standard insecticide for sucking insects. Commercial nicotine sulphate, containing 40 per cent of nicotine, is available on the market. When used alone, soap or a casein-lime emulsifier should be added in order to make it spread and stick. In this bulletin nicotine sulphate is recommended for the control of southern green plant bugs and the rusty-brown plum aphid. On peach trees it is generally used at the rate of one-half pint to 50 gallons of water, with 1½ pounds of soap or 6 ounces of a casein-lime mixture.

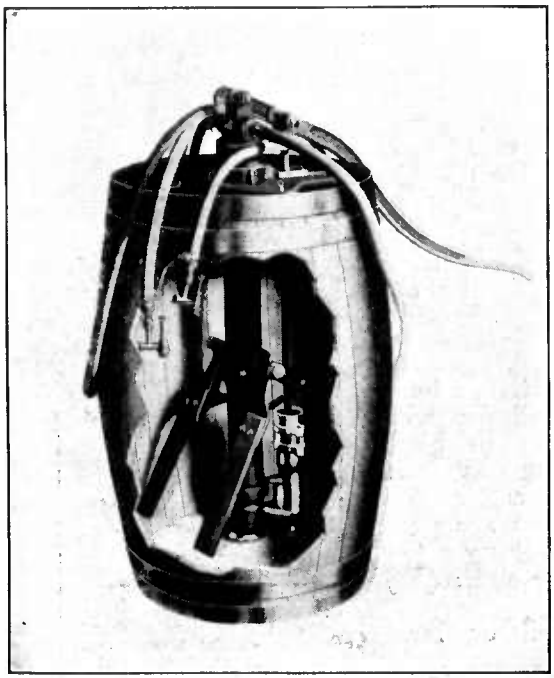

FIG. 25.—Barrel spray pump for orchards up to 5 acres. This outfit should be equipped with a 4-foot extension rod and 25 feet of hose. (Qualutance and Siegler)

LUBRICATING-OIL EMULSION

Lubricating-oil emulsion is recommended for the control of the San Jose, terrapin, and West Indian peach scales. The concentrated stock emulsion can be purchased from manufacturers, or can be made according to directions given on pages 21 and 22. The stock emulsion should contain approximately 66⅔ per cent of oil. This should be diluted in the proportion of 9 gallons to 191 gallons of water for use on peach trees during the dormant season for the control of the above-named scale insects.

LIME-SULPHUR SOLUTION

Lime-sulphur solution is an old remedy for the San Jose scale. It is also recommended in this bulletin for the control of the West Indian peach scale, peach-twig borer, and rusty-brown aphid. The solution can be purchased from manufacturers, or it can be made on the farm as explained in Farmers' Bulletin No. 1285.[27] The concentrate should test 32° or 33° Baumé, and should be used at the rate of 1 part to 7 parts of water for scale control and at the rate of 1 to 10 for peach-twig borer control.

[27] SIEGLER, E. H., and DANIELS, A. M. See footnote 21.

POISONED-BRAN MASH

Poisoned-bran mash is used for the control of grasshoppers and the corn-ear worm. It should be placed in the orchard late in the evening or early in the morning at places where the insects have been working. Directions for preparing poisoned-bran mash are given on page 31.

PARADICHLOROBENZENE

Paradichlorobenzene is recommended for the control of the peach borer. It has also been suggested for the oriental peach moth. This crystalline material of about the fineness of granulated sugar can be

FIG. 26.—Power dusting machine for large home and commercial orchards

purchased readily on the market. For peach trees 4 and 5 years of age it should be used at the rate of three-fourths ounce per tree, and for trees 6 years of age and older the 1-ounce dose should be used (see page 13).

DUSTING MATERIAL

Dusts containing powdered lead arsenate are recommended for the control of the curculio and may be used for the control of other chewing insects. The mixture should contain 5 per cent of powdered lead arsenate, the remaining 95 per cent being made up of hydrated lime or of sulphur and hydrated lime (see p. 7). Where heavy infestations of chewing insects are to be controlled, the liquid spray may prove to be a little more effective than the dust.

BENEFICIAL INSECTS

There are several insects that assist materially in checking the multiplication of injurious peach insects. Ladybird beetles are perhaps the most beneficial to the peach grower. They prey upon scale insects, aphids, and thrips. The twice-stabbed ladybird beetle is usually prevalent on peach trees that are heavily infested with the San Jose scale. It is jet black in color and has two orange or red spots on the back. Ladybird beetles take their nourishment by sucking scale insects dry. They also assist materially in checking infestations of the rusty-brown plum aphid or other aphids. The adult and young ladybird beetles are sometimes erroneously thought to be the parents of aphids, on account of their close relation with these pests. Peach growers should encourage the multiplication of twice-stabbed and other ladybird beetles.

Syrphus flies, lace-wing flies, tachina flies, ground beetles, and some of the assassin bugs and praying mantids are other insects that are beneficial to the peach grower. Predacious and parasitic insects give considerable aid in controlling peach insects, and without the help of these beneficial insects it would be very difficult to grow a crop of peaches, even though artificial control measures were enforced.

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